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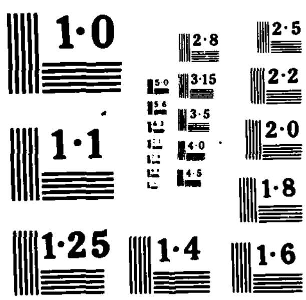
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MELBOURNE, VICTORIA

STRUCTURES REPORT 413

EFFECT OF EDGE DISTANCE ON YIELD INITIATION IN A REMOTELY LOADED HALF-PLANE CONTAINING A BONDED INTERFERENCE-FIT DISC OF THE SAME MATERIAL

by

G S. JOST and R. P. CAREY

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SUMMARY

The threshold combinations of interference-fit and remote loading required to initiate yield in a half-plane containing a bonded disc of the same material are evaluated analytically. Comprehensive tabular data are given over the full range of ratio of hole edge distance to hole radius, together with graphical presentations for selected cases.

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A1

NOMENCLATURE

a	distance from hole centre to plate boundary (free edge)
E	Young's modulus
q	non-dimensionalising parameter [$= E\lambda/2$ for plane stress]
r	radius from hole centre to point z
R	radius of hole
S	remote stress applied at infinity
x, y	Cartesian coordinates
Y	yield stress
z	location of point under consideration
θ	angle at hole centre between x axis and point z
λ	radial interference/R
$\widehat{rr}$, $\widehat{\theta\theta}$	polar stresses, radial and circumferential
$\widehat{r\theta}$	polar shear stress

1. INTRODUCTION

It has been shown that the edge distance of a hole in a semi-infinite plate containing a bonded interference-fit disc has a marked influence on the resulting local stress field.[1] In particular, the stress maxima and minima and their locations are not obvious, and although not difficult to identify, they do require evaluation for each specific case. Similarly, the location of the point(s) in the plate from which yield will spread, whether from interference-fitting alone or in combination with remote loading, is not known in advance.

In this report the initiation of yield in terms of both interference-fit and remote loading parameters is evaluated over the full range of edge distance ratios, i.e. from $a/R = 1$ to $a/R = \infty$.

2. STRESSES

The elastic stresses in a half-plane, Fig. 1, arising from a bonded interference-fit disc of the same material are[2]:

$$\begin{pmatrix} \widehat{rr}/q \\ \widehat{\theta\theta}/q \end{pmatrix}_{\mathrm{I}} = \mp\frac{R^2}{r^2} + 2R^2\frac{A^2-B^2}{(A^2+B^2)^2} \pm \frac{LR^2}{(A^2+B^2)^3} \qquad \begin{matrix}(1)\\(2)\end{matrix}$$

and

$$(\widehat{r\theta}/q)_{\mathrm{I}} = \frac{MR^2}{(A^2+B^2)^3} \qquad (3)$$

where the subscript (I) refers to interference-fitting,

$$A = 2a + r\cos\theta,$$

$$B = r\sin\theta,$$

and

$$\begin{pmatrix} L \\ M \end{pmatrix} = \left\{ 2[4AB(A^2-B^2) - aB(3A^2-B^2)]\begin{pmatrix} \sin 2\theta \\ \cos 2\theta \end{pmatrix} + rB(3A^2-B^2)\begin{pmatrix} \sin 3\theta \\ \cos 3\theta \end{pmatrix} \right.$$

$$\left. \pm 2[A^4 - 6A^2B^2 + B^4 - aA(A^2-3B^2)]\begin{pmatrix} \cos 2\theta \\ \sin 2\theta \end{pmatrix} \pm rA(A^2-3B^2)\begin{pmatrix} \cos 3\theta \\ \sin 3\theta \end{pmatrix} \right\}.$$

In a plate containing a bonded neat-fit insert of the same material, the elastic stresses arising from remote loading alone are simply those in a similar plate without a hole. In terms of the present polar notation the stresses arising are:

$$(\widehat{rr}/q)_S = (S/q)\sin^2\theta \qquad (4)$$

$$(\widehat{\theta\theta}/q)_S = (S/q)\cos^2\theta \qquad (5)$$

and

$$(\widehat{r\theta}/q)_S = (S/q)\sin\theta\cos\theta \qquad (6)$$

where the subscript (S) refers to remote loading.

Algebraic summing of like components above provides the stresses acting at any point in the plate under the actions of both interference-fit and remote loading. For example,

$$\widehat{rr}/q = (\widehat{rr}/q)_I + (\widehat{rr}/q)_S.$$

3. INITIATION OF YIELD

Plane stress conditions are assumed in this analysis. For non-principal stresses, the von Mises yield criterion is:

$$\widehat{rr}^2 + \widehat{\theta\theta}^2 - \widehat{rr}\,\widehat{\theta\theta} + 3\,\widehat{r\theta}^2 = Y^2$$

or

$$(\widehat{rr}/q)^2 + (\widehat{\theta\theta}/q)^2 - (\widehat{rr}/q)(\widehat{\theta\theta}/q) + 3(\widehat{r\theta}/q)^2 - (Y/q)^2 = 0. \tag{7}$$

Substitution of (1)+(4), (2)+(5) and (3)+(6) into (7) gives

$$(S/q)^2 + (S/q)b + c - (Y/q)^2 = 0 \tag{8}$$

where

$$b = (\widehat{rr}/q)_I(3\sin^2\theta - 1) + (\widehat{\theta\theta}/q)_I(3\cos^2\theta - 1) + 3(\widehat{r\theta}/q)_I \sin 2\theta$$

and

$$c = (\widehat{rr}/q)_I^2 + (\widehat{\theta\theta}/q)_I^2 - (\widehat{rr}/q)_I(\widehat{\theta\theta}/q)_I + 3(\widehat{r\theta}/q)_I^2.$$

It is convenient for later presentations to rewrite (8) in terms of the non-dimensional parameters S/Y and $\lambda/(Y/E)$. Since, for plane stress, $q = E\lambda/2$, Ref 2, (8) becomes:

$$\left(\frac{S}{Y}\right)^2 + \frac{\lambda}{Y/E}\frac{b}{2}\frac{S}{Y} + \frac{c}{4}\left(\frac{\lambda}{Y/E}\right)^2 - 1 = 0.$$

This equation can be solved readily for either parameter:

$$\frac{S}{Y} = -\frac{\lambda}{Y/E}\frac{b}{4} \pm \sqrt{\left(\frac{\lambda}{Y/E}\right)^2\left[\left(\frac{b}{4}\right)^2 - \frac{c}{4}\right] + 1} \tag{9}$$

or

$$\frac{\lambda}{Y/E} = -\frac{S}{Y}\frac{b}{c} + \sqrt{\left(\frac{S}{Y}\right)^2\left[\left(\frac{b}{c}\right)^2 - \frac{4}{c}\right] + \frac{4}{c}} \tag{10}$$

Thus, for given geometry (θ, b and c) and material (Y/E) the combination of interference and remote loads to initiate yield at any point in either the plate (or the disc*) may be calculated from (9) and (10). There is a problem, however, in that, in general, the *location* of the point of yield initiation is not known in advance. This means that yield initiation at various locations must be evaluated so that the threshold combinations of interference-fit and remote loading to initiate yield can be identified.

Yielding occurs in the plate either on the free edge or at the hole interface. Along the free edge both normal and shear stresses vanish so that the location of the maximum tangential stress on the free edge becomes that of initial yield: this point is invariably[2] at the origin, Fig. 1. Around the hole interface the points of initial yield are both geometry and load dependent and

* A check on the loadings required to initiate yield in the disc reveals that, in the presence of interference-fit stresses, these always exceed those required to initiate yield in the plate: yield is always initiated first in the plate (provided the yield stress of the disc is of the same order as or greater than that of the plate).

must be identified by numerical evaluation. A comparison of the conditions causing yield on each of the two boundaries determines at which location yield first occurs.

Before examining the general case of both interference-fit and remote loading, it is useful to consider the separate cases where one or the other loading parameter is absent.

(a) *No remote loading*

In this case

$$S/Y = 0$$

and (10) becomes:

$$\lambda/(Y/E) = 2/\sqrt{c}. \tag{11}$$

Equation (11) has been evaluated on the free edge at the origin* and around the hole for several values of a/R. Figure 2 shows that at values of a/R up to $1 \cdot 45$ yielding occurs first at the origin: beyond this value it occurs first at the hole. The lower graph shows the location of yielding around the hole, again as a function of a/R. The valid region of this graph is for $a/R \geqslant 1 \cdot 45$ only, so that with increasing a/R yielding around the hole occurs first at $\theta = 131°$ when $a/R = 1 \cdot 45$, θ asymptoting slowly towards 90° for larger a/R. Notice that yield never initiates first at the hole adjacent to the free edge ($\theta = 180°$) when remote loading is absent.

(b) *No interference fit* (neat-fit insert)

In this case

$$\lambda/(Y/E) = 0$$

and (9) becomes:

$$S/Y = \pm 1 \tag{12}$$

and thus general yielding occurs throughout both plate and disc. The situation is simply uniaxial tensile or compressive yield of the half plane.

(c) *Combined interference-fit and remote loading*

The situation has been outlined above. Evaluation of (9) and (10) on the free edge at the origin is straightforward. However, around the hole, the location of yield initiation is unknown, and thus (9) and (10) have been evaluated at $0 \cdot 1$ degree intervals for representative a/R to discover those combinations of the loading parameters which initiate yield.

There are three main non-dimensional parameters involved in defining the location of yielding around the hole: one geometric and two loading parameters, together with the angle θ. These data are given in Table 1 and in Figs 3, 4 and 5, where in each case two of the parameters are varied while the third is maintained constant. One of these graphs (Fig. 4) also allows the various θ regimes to be seen.

Figure 3 is a generalisation of Figure 2 to include lines of constant S/Y. Those sections of the lines which are invalid (because of prior yielding elsewhere) have been omitted. This graph shows that under positive remote loading yield initiates at the hole at about $a/R = 1 \cdot 5$ irrespective of the value of S/Y, whereas under negative loading the situation is rather different.

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* At the origin (11) simplifies to

$$\lambda/(Y/E) = \tfrac{1}{4}(a/R)^2(1-S/Y).$$

As S/Y becomes negative the changeover a/R value (from initial yield at the free edge to yield at the hole) decreases until, for $S/Y \leqslant -0{\cdot}4505$, yield initiates always at the hole.

This behaviour can be seen more clearly in Fig. 4, where S/Y is plotted against a/R for constant $\lambda/(Y/E)$. This delineates clearly the regions of initial yield, whether at the edge or at the hole. In the latter case the *location* of yielding around the hole is also shown in five regions*:

$$\theta = 180^\circ$$

$$180^\circ > \theta \geqslant 95^\circ$$

$$95^\circ > \theta > 90^\circ$$

$$\theta = 90^\circ$$

$$\theta < 90^\circ$$

At high a/R, θ becomes 90° for negative S/Y and 180° for positive S/Y. Although for low a/R an accurate description is difficult, the same statement is approximately correct. The combination of the loading parameters S/Y and $\lambda/(Y/E)$ to cause the initiation of yield at the hole is almost independent of a/R — the main influence of a/R is in determining when the location of yield changes from the free edge to the hole interface. For a/R greater than $1{\cdot}5187$ yield initiates at the hole, irrespective of the magnitude of the remote loading.

This insensitivity of the parameter a/R (except for its lowest values) in relation to the combinations of loading parameters which initiate yielding can also be seen in Figs 5(*a*) and 5(*b*), where S/Y is plotted against $\lambda/(Y/E)$ for constant a/R. Figure 5(*b*) shows that, for a given interference, some plates of finite a/R can even sustain slightly higher positive values of S/Y (but reduced negative values) than can an infinite plate before yielding occurs. The situation for negative S/Y conforms more to expectation.

For a/R greater than $1{\cdot}5187$, where yield initiates always at the hole, the maximum value of interference to initiate yield (refer to Fig. 5) is found where (9) becomes single valued. By equating the radical to zero, the non-dimensional interference is given by:

$$\lambda/(Y/E) = 2/\sqrt{4c-b^2} \tag{13}$$

This must be maximised with respect to θ, after which, again from (9):

$$S/Y = -[\lambda/(Y/E)](b/4). \tag{14}$$

The maxima from (13) and (14) together with the corresponding values of θ are listed as the final entries for each value of a/R in Table 1.

4. CONCLUSIONS

Under the actions of both interference-fit and remote loading sufficient to initiate yield, a half-plane containing a bonded insert of the same material exhibits the following characteristics.

1. The location of the point(s) of yield initiation is dependent upon the hole/edge distance geometry, and the combinations of interference-fit and remote loading parameters.

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* The positions of the dotted lines in Fig. 4 are approximate only.

2. For edge distance ratios (a/R) greater than $1 \cdot 5187$, and for remote to yield stress ratios (S/Y) of less than $-0 \cdot 4505$, yield always initiates at the hole interface. In the region where a/R is less than $1 \cdot 5187$ and S/Y is greater than $-0 \cdot 4505$ yield initiates either at the hole or at the free edge adjacent to the hole, depending upon interference-fit and remote loading.

3. At very high a/R, yielding initiates at the hole at the point nearest to the free edge ($\theta = 180°$) for positive S/Y and at the point $\theta = 90°$ for negative S/Y: the same is also approximately true for lower values of a/R where yielding occurs at the hole interface.

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1. Richardson, M.K. — Interface stresses in a half plane containing an elastic disk of the same material. *J. Appl. Mech.*, vol. 36, March 1969, pp. 128–130.

2. Jost, G. S. and Carey, R. P. — Elastic response of a half-plane to a bonded interference-fit disc of the same material. *Dept. Defence, Aeronaut. Res. Labs*, Structures Report 406, July 1984.

TABLE 1: INTERFERENCE-FIT AND REMOTE LOADING COMBINATIONS TO INITIATE YIELD

a/R=1.0

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9000	180.0	-0.9670	86.5
0.1000	0.8000	180.0	-0.9333	86.7
0.1500	0.7000	180.0	-0.8989	86.8
0.2000	0.6000	180.0	-0.8638	86.9
0.2500	0.5000	180.0	-0.8281	87.1
0.3000	0.4000	180.0	-0.7916	87.3
0.3500	0.3000	180.0	-0.7545	87.5
0.4000	0.2000	180.0	-0.7166	87.7
0.4500	0.1000	180.0	-0.6779	87.9
0.5000	0.0000	180.0	-0.6385	88.2
0.5500	-0.1000	180.0	-0.5983	88.5
0.6000	-0.2000	180.0	-0.5573	88.9
0.6500	-0.3000	180.0	-0.5153	89.3
0.7000	-0.4000	180.0	-0.4725	89.8
0.7252	-0.4505	90.1*		

a/R=1.1

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9174	EDGE	-0.9657	87.3
0.1000	0.8347	EDGE	-0.9306	87.4
0.1500	0.7521	EDGE	-0.8949	87.5
0.2000	0.6694	EDGE	-0.8584	87.7
0.2500	0.5868	EDGE	-0.8213	87.9
0.3000	0.5041	EDGE	-0.7834	88.1
0.3500	0.4215	EDGE	-0.7448	88.3
0.4000	0.3388	EDGE	-0.7055	88.5
0.4500	0.2562	EDGE	-0.6654	88.8
0.5000	0.1736	EDGE	-0.6245	89.1
0.5500	0.0909	EDGE	-0.5827	89.4
0.6000	0.0083	EDGE	-0.5401	89.8
0.6500	-0.0744	EDGE	-0.4965	90.3
0.7000	-0.1570	EDGE	-0.4520	90.9
0.7500	-0.2397	EDGE	-0.4064	91.6
0.8000	-0.3223	EDGE	-0.3595	92.6
0.8143	-0.3459	92.9*		

a/R=1.2

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9306	EDGE	-0.9647	87.9
0.1000	0.8611	EDGE	-0.9287	88.0
0.1500	0.7917	EDGE	-0.8920	88.1
0.2000	0.7222	EDGE	-0.8546	88.3
0.2500	0.6528	EDGE	-0.8164	88.5
0.3000	0.5833	EDGE	-0.7776	88.7
0.3500	0.5139	EDGE	-0.7380	88.9
0.4000	0.4444	EDGE	-0.6977	89.1
0.4500	0.3750	EDGE	-0.6565	89.4
0.5000	0.3056	EDGE	-0.6146	89.7
0.5500	0.2361	EDGE	-0.5718	90.1
0.6000	0.1667	EDGE	-0.5282	90.5
0.6500	0.0972	EDGE	-0.4836	91.0
0.7000	0.0278	EDGE	-0.4380	91.6
0.7500	-0.0417	EDGE	-0.3913	92.4
0.8000	-0.1111	EDGE	-0.3434	93.4
0.8500	-0.1806	EDGE	-0.2938	94.8
0.8968	-0.2456	96.7*		

a/R=1.3

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9408	EDGE	-0.9640	88.3
0.1000	0.8817	EDGE	-0.9273	88.4
0.1500	0.8225	EDGE	-0.8899	88.6
0.2000	0.7633	EDGE	-0.8518	88.7
0.2500	0.7041	EDGE	-0.8130	88.9
0.3000	0.6450	EDGE	-0.7734	89.1
0.3500	0.5858	EDGE	-0.7332	89.3
0.4000	0.5266	EDGE	-0.6922	89.5
0.4500	0.4675	EDGE	-0.6504	89.8
0.5000	0.4083	EDGE	-0.6078	90.1
0.5500	0.3491	EDGE	-0.5644	90.4
0.6000	0.2899	EDGE	-0.5201	90.9
0.6500	0.2308	EDGE	-0.4749	91.4
0.7000	0.1716	EDGE	-0.4287	92.0
0.7500	0.1124	EDGE	-0.3814	92.8
0.8000	0.0533	EDGE	-0.3329	93.8
0.8500	-0.0059	EDGE	-0.2828	95.2
0.9000	-0.0651	EDGE	-0.2308	97.3
0.9500	-0.1243	EDGE	-0.1754	100.7
0.9716	-0.1498	103.0*		

a/R=1.4

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9490	EDGE	-0.9635	88.7
0.1000	0.8980	EDGE	-0.9262	88.8
0.1500	0.8469	EDGE	-0.8883	88.9
0.2000	0.7959	EDGE	-0.8498	89.1
0.2500	0.7449	EDGE	-0.8105	89.2
0.3000	0.6939	EDGE	-0.7705	89.4
0.3500	0.6429	EDGE	-0.7298	89.6
0.4000	0.5918	EDGE	-0.6883	89.8
0.4500	0.5408	EDGE	-0.6461	90.1
0.5000	0.4898	EDGE	-0.6031	90.3
0.5500	0.4388	EDGE	-0.5593	90.7
0.6000	0.3878	EDGE	-0.5147	91.1
0.6500	0.3367	EDGE	-0.4691	91.5
0.7000	0.2857	EDGE	-0.4226	92.1
0.7500	0.2347	EDGE	-0.3751	92.9
0.8000	0.1837	EDGE	-0.3263	93.8
0.8500	0.1327	EDGE	-0.2762	95.2
0.9000	0.0816	EDGE	-0.2241	97.1
0.9500	0.0306	EDGE	-0.1691	100.4
1.0000	-0.0204	EDGE	-0.1076	106.9
1.0329	-0.0539	117.5*		

a/R=1.5

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9556	EDGE	-0.9631	88.9
0.1000	0.9111	EDGE	-0.9255	89.0
0.1500	0.8667	EDGE	-0.8872	89.2
0.2000	0.8222	EDGE	-0.8483	89.3
0.2500	0.7778	EDGE	-0.8087	89.4
0.3000	0.7333	EDGE	-0.7684	89.6
0.3500	0.6889	EDGE	-0.7274	89.8
0.4000	0.6444	EDGE	-0.6856	90.0
0.4500	0.6000	EDGE	-0.6432	90.2
0.5000	0.5556	EDGE	-0.5999	90.5
0.5500	0.5111	EDGE	-0.5559	90.8
0.6000	0.4665	180.0	-0.5111	91.1
0.6500	0.4213	180.0	-0.4654	91.6
0.7000	0.3759	180.0	-0.4187	92.1
0.7500	0.3305	180.0	-0.3711	92.8
0.8000	0.2849	180.0	-0.3224	93.7
0.8500	0.2392	180.0	-0.2723	94.9
0.9000	0.1933	180.0	-0.2205	96.7
0.9500	0.1474	180.0	-0.1662	99.6
1.0000	0.1013	180.0	-0.1067	105.4
1.0500	0.0370	140.8	-0.0190	123.8
1.0540	0.0081	132.1		

* Simultaneous initiation of yield at edge and hole.

TABLE 1: (Cont)

a/R=1.6

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9580	180.0	-0.9628	89.1
0.1000	0.9158	180.0	-0.9250	89.2
0.1500	0.8734	180.0	-0.8865	89.4
0.2000	0.8309	180.0	-0.8473	89.5
0.2500	0.7883	.80.0	-0.8074	89.6
0.3000	0.7455	180.0	-0.7669	89.8
0.3500	0.7026	180.0	-0.7257	89.9
0.4000	0.6595	180.0	-0.6838	90.1
0.4500	0.6162	180.0	-0.6412	90.3
0.5000	0.5728	180.0	-0.5978	90.5
0.5500	0.5292	180.0	-0.5537	90.8
0.6000	0.4855	180.0	-0.5067	91.2
0.6500	0.4416	180.0	-0.4630	91.6
0.7000	0.3976	180.0	-0.4163	92.0
0.7500	0.3534	180.0	-0.3688	92.7
0.8000	0.3091	180.0	-0.3201	93.5
0.8500	0.2646	180.0	-0.2702	94.6
0.9000	0.2199	180.0	-0.2189	96.2
0.9500	0.1751	180.0	-0.1653	98.7
1.0000	0.1301	180.0	-0.1076	103.6
1.0500	0.0730	148.5	-0.0344	116.9
1.0642	0.0200	132.3		

a/R=1.7

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9592	180.0	-0.9626	89.3
0.1000	0.9181	180.0	-0.9246	89.4
0.1500	0.8769	180.0	-0.8859	89.5
0.2000	0.8355	180.0	-0.8465	89.6
0.2500	0.7939	180.0	-0.8066	89.7
0.3000	0.7522	180.0	-0.7659	89.9
0.3500	0.7102	180.0	-0.7246	90.0
0.4000	0.6681	180.0	-0.6825	90.2
0.4500	0.6258	180.0	-0.6398	90.4
0.5000	0.5833	180.0	-0.5964	90.6
0.5500	0.5406	180.0	-0.5522	90.8
0.6000	0.4977	180.0	-0.5073	91.1
0.6500	0.4546	180.0	-0.4615	91.5
0.7000	0.4114	180.0	-0.4149	91.9
0.7500	0.3679	180.0	-0.3674	92.5
0.8000	0.3243	180.0	-0.3190	93.2
0.8500	0.2804	180.0	-0.2694	94.2
0.9000	0.2364	180.0	-0.2184	95.6
0.9500	0.1922	180.0	-0.1655	97.8
1.0000	0.1477	180.0	-0.1094	102.0
1.0500	0.0964	154.0	-0.0433	112.4
1.0742	0.0277	132.5		

a/R=1.8

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9600	180.0	-0.9625	89.4
0.1000	0.9197	180.0	-0.9243	89.5
0.1500	0.8793	180.0	-0.8855	89.6
0.2000	0.8386	180.0	-0.8460	89.7
0.2500	0.7978	180.0	-0.8059	89.8
0.3000	0.7567	180.0	-0.7652	89.9
0.3500	0.7154	180.0	-0.7238	90.1
0.4000	0.6739	180.0	-0.6817	90.2
0.4500	0.6322	180.0	-0.6390	90.4
0.5000	0.5902	180.0	-0.5955	90.6
0.5500	0.5481	180.0	-0.5513	90.8
0.6000	0.5057	180.0	-0.5064	91.1
0.6500	0.4631	180.0	-0.4607	91.4
0.7000	0.4203	180.0	-0.4142	91.8
0.7500	0.3773	180.0	-0.3668	92.3
0.8000	0.3340	180.0	-0.3185	92.9
0.8500	0.2905	180.0	-0.2692	93.8
0.9000	0.2468	180.0	-0.2186	95.0
0.9500	0.2028	180.0	-0.1664	97.0
1.0000	0.1586	180.0	-0.1116	100.5
1.0500	0.1114	159.5	-0.0497	109.0
1.0835	0.0351	132.6		

a/R=1.9

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9606	180.0	-0.9623	89.5
0.1000	0.9209	180.0	-0.9241	89.6
0.1500	0.8810	180.0	-0.8852	89.7
0.2000	0.8408	180.0	-0.8456	89.8
0.2500	0.8004	180.0	-0.8055	89.9
0.3000	0.7598	180.0	-0.7647	90.0
0.3500	0.7190	180.0	-0.7233	90.1
0.4000	0.6779	180.0	-0.6812	90.2
0.4500	0.6365	180.0	-0.6384	90.4
0.5000	0.5949	180.0	-0.5950	90.6
0.5500	0.5531	180.0	-0.5508	90.8
0.6000	0.5110	180.0	-0.5059	91.0
0.6500	0.4687	180.0	-0.4603	91.3
0.7000	0.4262	180.0	-0.4139	91.6
0.7500	0.3833	180.0	-0.3667	92.1
0.8000	0.3403	180.0	-0.3186	92.6
0.8500	0.2969	180.0	-0.2695	93.4
0.9000	0.2533	180.0	-0.2193	94.5
0.9500	0.2095	180.0	-0.1676	96.2
1.0000	0.1653	180.0	-0.1138	99.3
1.0500	0.1204	166.2	-0.0548	106.3
1.0919	0.0373	132.8		

a/R=2.0

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9610	180.0	-0.9623	89.6
0.1000	0.9217	180.0	-0.9239	89.7
0.1500	0.8822	180.0	-0.8850	89.8
0.2000	0.8424	180.0	-0.8454	89.8
0.2500	0.8023	180.0	-0.8052	89.9
0.3000	0.7620	180.0	-0.7644	90.0
0.3500	0.7215	180.0	-0.7229	90.1
0.4000	0.6806	180.0	-0.6808	90.2
0.4500	0.6395	180.0	-0.6381	90.4
0.5000	0.5982	180.0	-0.5947	90.5
0.5500	0.5565	180.0	-0.5506	90.7
0.6000	0.5146	180.0	-0.5058	90.9
0.6500	0.4725	180.0	-0.4602	91.2
0.7000	0.4300	180.0	-0.4140	91.5
0.7500	0.3873	180.0	-0.3669	91.9
0.8000	0.3443	180.0	-0.3189	92.4
0.8500	0.3010	180.0	-0.2701	93.1
0.9000	0.2574	180.0	-0.2202	94.0
0.9500	0.2136	180.0	-0.1690	95.6
1.0000	0.1694	180.0	-0.1160	98.2
1.0500	0.1249	180.0	-0.0590	104.1
1.0993	0.0377	133.0		

a/R=2.1

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9613	180.0	-0.9622	89.7
0.1000	0.9223	180.0	-0.9238	89.7
0.1500	0.8831	180.0	-0.8848	89.8
0.2000	0.8435	180.0	-0.8452	89.9
0.2500	0.8037	180.0	-0.8050	89.9
0.3000	0.7636	180.0	-0.7642	90.0
0.3500	0.7232	180.0	-0.7227	90.1
0.4000	0.6826	180.0	-0.6806	90.2
0.4500	0.6416	180.0	-0.6379	90.4
0.5000	0.6004	180.0	-0.5946	90.5
0.5500	0.5589	180.0	-0.5505	90.7
0.6000	0.5171	180.0	.5058	90.9
0.6500	0.4750	180.0	-0.4603	91.1
0.7000	0.4326	180.0	-0.4142	91.4
0.7500	0.3899	180.0	-0.3672	91.7
0.8000	0.3469	180.0	-0.3195	92.2
0.8500	0.3036	180.0	-0.2709	92.8
0.9000	0.2599	180.0	-0.2212	93.6
0.9500	0.2160	180.0	-0.1705	95.0
1.0000	0.1717	180.0	-0.1180	97.3
1.0500	0.1271	180.0	-0.0625	102.3
1.1000	0.0676	145.1	0.0106	121.3
1.1058	0.0396	133.1		

TABLE 1: (Cont)

a/R=2.2

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9615	180.0	-0.9622	89.7
0.1000	0.9228	180.0	-0.9237	89.8
0.1500	0.8837	180.0	-0.8847	89.8
0.2000	0.8443	180.0	-0.8451	89.9
0.2500	0.8047	180.0	-0.8049	90.0
0.3000	0.7647	180.0	-0.7640	90.0
0.3500	0.7245	180.0	-0.7226	90.1
0.4000	0.6839	180.0	-0.6806	90.2
0.4500	0.6'31	180.0	-0.6379	90.3
0.5000	0.6019	180.0	-0.5946	90.5
0.5500	0.5605	180.0	-0.5506	90.6
0.6000	0.5187	180.0	-0.5059	90.8
0.6500	0.4766	180.0	-0.4606	91.0
0.7000	0.4342	180.0	-0.4145	91.2
0.7500	0.3915	180.0	-0.3677	91.6
0.8000	0.3485	180.0	-0.3201	92.0
0.8500	0.3051	180.0	-0.2717	92.5
0.9000	0.2614	180.0	-0.2223	93.3
0.9500	0.2173	180.0	-0.1719	94.4
1.0000	0.1729	180.0	-0.1200	96.5
1.0500	0.1282	180.0	-0.0656	100.8
1.1000	0.0766	151.5	0.0001	116.1
1.1115	0.0404	133.2		

a/R=2.3

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9617	180.0	-0.9621	89.8
0.1000	0.9231	180.0	-0.9237	89.8
0.1500	0.8842	180.0	-0.8846	89.9
0.2000	0.8450	180.0	-0.8450	89.9
0.2500	0.8054	180.0	-0.8048	90.0
0.3000	0.7656	180.0	-0.7640	90.1
0.3500	0.7254	180.0	-0.7226	90.1
0.4000	0.6849	180.0	-0.6805	90.2
0.4500	0.6441	180.0	-0.6379	90.3
0.5000	0.6030	180.0	-0.5946	90.4
0.5500	0.5616	180.0	-0.5507	90.6
0.6000	0.5198	180.0	-0.5062	90.7
0.6500	0.4777	180.0	-0.4609	90.9
0.7000	0.4353	180.0	-0.4150	91.1
0.7500	0.3925	180.0	-0.3683	91.4
0.8000	0.3494	180.0	-0.3208	91.8
0.8500	0.3059	180.0	-0.2726	92.3
0.9000	0.2621	180.0	-0.2235	92.9
0.9500	0.2179	180.0	-0.1733	94.0
1.0000	0.1734	180.0	-0.1219	95.8
1.0500	0.1285	180.0	-0.0683	99.5
1.1000	0.0808	157.4	-0.0067	112.4
1.1164	0.0375	133.4		

a/R=2.4

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9618	180.0	-0.9621	89.8
0.1000	0.9234	180.0	-0.9236	89.8
0.1500	0.8845	180.0	-0.8846	89.9
0.2000	0.8454	180.0	-0.8450	89.9
0.2500	0.8060	180.0	-0.8048	90.0
0.3000	0.7662	180.0	-0.7640	90.1
0.3500	0.7261	180.0	-0.7226	90.1
0.4000	0.6856	180.0	-0.6806	90.2
0.4500	0.6449	180.0	-0.6380	90.3
0.5000	0.6038	180.0	-0.5948	90.4
0.5500	0.5623	180.0	-0.5509	90.5
0.6000	0.5205	180.0	-0.5064	90.7
0.6500	0.4784	180.0	-0.4613	90.8
0.7000	0.4359	180.0	-0.4154	91.0
0.7500	0.3931	180.0	-0.3689	91.3
0.8000	0.3499	180.0	-0.3216	91.6
0.8500	0.3063	180.0	-0.2735	92.0
0.9000	0.2624	180.0	-0.2245	92.7
0.9500	0.2181	180.0	-0.1747	93.6
1.0000	0.1734	180.0	-0.1236	95.2
1.0500	0.1283	180.0	-0.0707	98.5
1.1000	0.0822	164.2	-0.0118	109.4
1.1207	0.0369	133.5		

a/R=2.5

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9619	180.0	-0.9621	89.8
0.1000	0.9236	180.0	-0.9236	89.9
0.1500	0.8848	180.0	-0.8846	89.9
0.2000	0.8458	180.0	-0.8449	90.0
0.2500	0.8064	180.0	-0.8048	90.0
0.3000	0.7666	180.0	-0.7640	90.1
0.3500	0.7266	180.0	-0.7226	90.1
0.4000	0.6861	180.0	-0.6807	90.2
0.4500	0.6454	180.0	-0.6381	90.3
0.5000	0.6043	180.0	-0.5950	90.4
0.5500	0.5628	180.0	-0.5512	90.5
0.6000	0.5210	180.0	-0.5067	90.6
0.6500	0.4788	180.0	-0.4617	90.8
0.7000	0.4363	180.0	-0.4159	90.9
0.7500	0.3934	180.0	-0.3695	91.2
0.8000	0.3501	180.0	-0.3223	91.5
0.8500	0.3064	180.0	-0.2744	91.9
0.9000	0.2624	180.0	-0.2256	92.4
0.9500	0.2179	180.0	-0.1760	93.2
1.0000	0.1731	180.0	-0.1252	94.6
1.0500	0.1278	180.0	-0.0728	97.6
1.1000	0.0821	176.4	-0.0158	107.0
1.1244	0.0359	133.6		

a/R=2.6

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9620	180.0	-0.9621	89.8
0.1000	0.9237	180.0	-0.9236	89.9
0.1500	0.8850	180.0	-0.8846	89.9
0.2000	0.8460	180.0	-0.8449	90.0
0.2500	0.8067	180.0	-0.8048	90.0
0.3000	0.7670	180.0	-0.7640	90.1
0.3500	0.7269	180.0	-0.7227	90.1
0.4000	0.6865	180.0	-0.6808	90.2
0.4500	0.6457	180.0	-0.6383	90.3
0.5000	0.6046	180.0	-0.5952	90.3
0.5500	0.5631	180.0	-0.5514	90.4
0.6000	0.5213	180.0	-0.5071	90.6
0.6500	0.4790	180.0	-0.4621	90.7
0.7000	0.4364	180.0	-0.4164	90.9
0.7500	0.3934	180.0	-0.3701	91.1
0.8000	0.3501	180.0	-0.3230	91.3
0.8500	0.3063	180.0	-0.2752	91.7
0.9000	0.2621	180.0	-0.2266	92.2
0.9500	0.2175	180.0	-0.1772	92.9
1.0000	0.1725	180.0	-0.1267	94.2
1.0500	0.1271	180.0	-0.0748	96.8
1.1000	0.0812	180.0	-0.0191	105.1
1.1276	0.0344	133.7		

a/R=2.7

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9621	180.0	-0.9621	89.9
0.1000	0.9238	180.0	-0.9236	89.9
0.1500	0.8852	180.0	-0.8846	89.9
0.2000	0.8462	180.0	-0.8450	90.0
0.2500	0.8069	180.0	-0.8048	90.0
0.3000	0.7672	180.0	-0.7641	90.1
0.3500	0.7272	180.0	-0.7228	90.1
0.4000	0.6867	180.0	-0.6809	90.2
0.4500	0.6460	180.0	-0.6384	90.2
0.5000	0.6048	180.0	-0.5954	90.3
0.5500	0.5633	180.0	-0.5517	90.4
0.6000	0.5214	180.0	-0.5074	90.5
0.6500	0.4791	180.0	-0.4625	90.6
0.7000	0.4364	180.0	-0.4169	90.8
0.7500	0.3934	180.0	-0.3707	91.0
0.8000	0.3499	180.0	-0.3237	91.2
0.8500	0.3060	180.0	-0.2761	91.5
0.9000	0.2618	180.0	-0.2276	92.0
0.9500	0.2170	180.0	-0.1783	92.7
1.0000	0.1719	180.0	-0.1281	93.8
1.0500	0.1263	180.0	-0.0765	96.1
1.1000	0.0803	180.0	-0.0219	103.4
1.1304	0.0326	133.8		

TABLE 1: (Cont)

a/R=2.8

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9621	180.0	-0.9621	89.9
0.1000	0.9239	180.0	-0.9236	89.9
0.1500	0.8853	180.0	-0.8846	89.9
0.2000	0.8464	180.0	-0.8450	90.0
0.2500	0.8071	180.0	-0.8048	90.0
0.3000	0.7674	180.0	-0.7641	90.1
0.3500	0.7273	180.0	-0.7229	90.1
0.4000	0.6869	180.0	-0.6810	90.2
0.4500	0.6461	180.0	-0.6386	90.2
0.5000	0.6049	180.0	-0.5956	90.3
0.5500	0.5634	180.0	-0.5520	90.4
0.6000	0.5214	180.0	-0.5077	90.5
0.6500	0.4791	180.0	-0.4629	90.6
0.7000	0.4364	180.0	-0.4174	90.7
0.7500	0.3932	180.0	-0.3712	90.9
0.8000	0.3497	180.0	-0.3244	91.1
0.8500	0.3057	180.0	-0.2768	91.4
0.9000	0.2613	180.0	-0.2285	91.8
0.9500	0.2165	180.0	-0.1794	92.4
1.0000	0.1712	180.0	-0.1294	93.4
1.0500	0.1254	180.0	-0.0781	95.5
1.1000	0.0792	180.0	-0.0243	102.0
1.1329	0.0336	133.8		

a/R=2.9

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9622	180.0	-0.9621	89.9
0.1000	0.9240	180.0	-0.9236	89.9
0.1500	0.8854	180.0	-0.8846	90.0
0.2000	0.8465	180.0	-0.8450	90.0
0.2500	0.8072	180.0	-0.8049	90.0
0.3000	0.7675	180.0	-0.7642	90.1
0.3500	0.7275	180.0	-0.7230	90.1
0.4000	0.6870	180.0	-0.6812	90.2
0.4500	0.6462	180.0	-0.6388	90.2
0.5000	0.6050	180.0	-0.5958	90.3
0.5500	0.5634	180.0	-0.5522	90.3
0.6000	0.5214	180.0	-0.5081	90.4
0.6500	0.4790	180.0	-0.4633	90.5
0.7000	0.4362	180.0	-0.4179	90.7
0.7500	0.3930	180.0	-0.3718	90.8
0.8000	0.3494	180.0	-0.3250	91.0
0.8500	0.3053	180.0	-0.2776	91.3
0.9000	0.2608	180.0	-0.2294	91.7
0.9500	0.2158	180.0	-0.1804	92.2
1.0000	0.1704	180.0	-0.1306	93.1
1.0500	0.1245	180.0	-0.0796	95.0
1.1000	0.0782	180.0	-0.0264	100.8
1.1350	0.0314	133.9		

a/R=3.0

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9622	180.0	-0.9621	89.9
0.1000	0.9240	180.0	-0.9236	89.9
0.1500	0.8855	180.0	-0.8846	90.0
0.2000	0.8466	180.0	-0.8450	90.0
0.2500	0.8073	180.0	-0.8049	90.0
0.3000	0.7676	180.0	-0.7643	90.1
0.3500	0.7275	180.0	-0.7231	90.1
0.4000	0.6871	180.0	-0.6813	90.1
0.4500	0.6462	180.0	-0.6389	90.2
0.5000	0.6050	180.0	-0.5960	90.3
0.5500	0.5634	180.0	-0.5525	90.3
0.6000	0.5213	180.0	-0.5084	90.4
0.6500	0.4789	180.0	-0.4637	90.5
0.7000	0.4360	180.0	-0.4183	90.6
0.7500	0.3927	180.0	-0.3723	90.7
0.8000	0.3490	180.0	-0.3257	90.9
0.8500	0.3049	180.0	-0.2783	91.2
0.9000	0.2603	180.0	-0.2302	91.5
0.9500	0.2152	180.0	-0.1814	92.0
1.0000	0.1697	180.0	-0.1317	92.9
1.0500	0.1237	180.0	-0.0809	94.6
1.1000	0.0772	180.0	-0.0282	99.7
1.1369	0.0291	134.0		

a/R=3.1

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9622	180.0	-0.9621	89.9
0.1000	0.9241	180.0	-0.9236	89.9
0.1500	0.8856	180.0	-0.8846	90.0
0.2000	0.8467	180.0	-0.8451	90.0
0.2500	0.8074	180.0	-0.8050	90.0
0.3000	0.7677	180.0	-0.7643	90.1
0.3500	0.7276	180.0	-0.7232	90.1
0.4000	0.6871	180.0	-0.6814	90.1
0.4500	0.6462	180.0	-0.6391	90.2
0.5000	0.6050	180.0	-0.5962	90.2
0.5500	0.5633	180.0	-0.5528	90.3
0.6000	0.5212	180.0	-0.5087	90.4
0.6500	0.4787	180.0	-0.4640	90.5
0.7000	0.4358	180.0	-0.4188	90.6
0.7500	0.3924	180.0	-0.3728	90.7
0.8000	0.3486	180.0	-0.3262	90.9
0.8500	0.3044	180.0	-0.2790	91.1
0.9000	0.2597	180.0	-0.2310	91.4
0.9500	0.2146	180.0	-0.1823	91.8
1.0000	0.1689	180.0	-0.1327	92.6
1.0500	0.1228	180.0	-0.0821	94.2
1.1000	0.0761	180.0	-0.0298	98.8
1.1386	0.0296	134.0		

a/R=3.2

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	89.9
0.1000	0.9241	180.0	-0.9236	89.9
0.1500	0.8856	180.0	-0.8846	90.0
0.2000	0.8467	180.0	-0.8451	90.0
0.2500	0.8074	180.0	-0.8050	90.0
0.3000	0.7677	180.0	-0.7644	90.1
0.3500	0.7276	180.0	-0.7233	90.1
0.4000	0.6871	180.0	-0.6816	90.1
0.4500	0.6462	180.0	-0.6393	90.2
0.5000	0.6049	180.0	-0.5964	90.2
0.5500	0.5632	180.0	-0.5530	90.3
0.6000	0.5211	180.0	-0.5090	90.3
0.6500	0.4785	180.0	-0.4644	90.4
0.7000	0.4356	180.0	-0.4192	90.5
0.7500	0.3921	180.0	-0.3733	90.6
0.8000	0.3483	180.0	-0.3268	90.8
0.8500	0.3040	180.0	-0.2796	91.0
0.9000	0.2592	180.0	-0.2317	91.3
0.9500	0.2139	180.0	-0.1831	91.7
1.0000	0.1682	180.0	-0.1336	92.4
1.0500	0.1219	180.0	-0.0833	93.8
1.1000	0.0752	180.0	-0.0313	98.0
1.1401	0.0270	134.1		

a/R=3.3

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	89.9
0.1000	0.9242	180.0	-0.9236	90.0
0.1500	0.8856	180.0	-0.8846	90.0
0.2000	0.8467	180.0	-0.8451	90.0
0.2500	0.8074	180.0	-0.8051	90.0
0.3000	0.7677	180.0	-0.7645	90.1
0.3500	0.7276	180.0	-0.7234	90.1
0.4000	0.6871	180.0	-0.6817	90.1
0.4500	0.6462	180.0	-0.6394	90.2
0.5000	0.6049	180.0	-0.5966	90.2
0.5500	0.5631	180.0	-0.5533	90.3
0.6000	0.5209	180.0	-0.5093	90.3
0.6500	0.4783	180.0	-0.4647	90.4
0.7000	0.4353	180.0	-0.4196	90.5
0.7500	0.3918	180.0	-0.3738	90.6
0.8000	0.3479	180.0	-0.3273	90.7
0.8500	0.3035	180.0	-0.2802	90.9
0.9000	0.2586	180.0	-0.2324	91.2
0.9500	0.2133	180.0	-0.1839	91.6
1.0000	0.1675	180.0	-0.1345	92.2
1.0500	0.1211	180.0	-0.0843	93.5
1.1000	0.0742	180.0	-0.0326	97.3
1.1414	0.0244	134.2		

TABLE 1: (Cont)

a/R=3.4

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	89.9
0.1000	0.9242	180.0	-0.9236	90.0
0.1500	0.8857	180.0	-0.8847	90.0
0.2000	0.8468	180.0	-0.8452	90.0
0.2500	0.8075	180.0	-0.8051	90.0
0.3000	0.7677	180.0	-0.7646	90.0
0.3500	0.7276	180.0	-0.7235	90.1
0.4000	0.6871	180.0	-0.6818	90.1
0.4500	0.6461	180.0	-0.6396	90.1
0.5000	0.6048	180.0	-0.5968	90.2
0.5500	0.5630	180.0	-0.5535	90.2
0.6000	0.5208	180.0	-0.5096	90.3
0.6500	0.4781	180.0	-0.4651	90.4
0.7000	0.4351	180.0	-0.4199	90.4
0.7500	0.3915	180.0	-0.3742	90.5
0.8000	0.3475	180.0	-0.3278	90.7
0.8500	0.3031	180.0	-0.2808	90.8
0.9000	0.2581	180.0	-0.2330	91.1
0.9500	0.2127	180.0	-0.1846	91.4
1.0000	0.1668	180.0	-0.1354	92.0
1.0500	0.1203	180.0	-0.0853	93.2
1.1000	0.0733	180.0	-0.0338	96.7
1.1425	0.0246	134.2		

a/R=3.7

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8847	90.0
0.2000	0.8468	180.0	-0.8453	90.0
0.2500	0.8075	180.0	-0.8053	90.0
0.3000	0.7677	180.0	-0.7648	90.0
0.3500	0.7276	180.0	-0.7237	90.1
0.4000	0.6870	180.0	-0.6822	90.1
0.4500	0.6460	180.0	-0.6400	90.1
0.5000	0.6045	180.0	-0.5974	90.2
0.5500	0.5626	180.0	-0.5541	90.2
0.6000	0.5203	180.0	-0.5103	90.2
0.6500	0.4775	180.0	-0.4659	90.3
0.7000	0.4343	180.0	-0.4209	90.4
0.7500	0.3906	180.0	-0.3753	90.4
0.8000	0.3465	180.0	-0.3291	90.5
0.8500	0.3018	180.0	-0.2823	90.7
0.9000	0.2567	180.0	-0.2347	90.9
0.9500	0.2110	180.0	-0.1865	91.1
1.0000	0.1649	180.0	-0.1375	91.6
1.0500	0.1182	180.0	-0.0877	92.5
1.1000	0.0709	180.0	-0.0369	95.2
1.1453	0.0222	134.3		

a/R=3.5

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	89.9
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8847	90.0
0.2000	0.8468	180.0	-0.8452	90.0
0.2500	0.8075	180.0	-0.8052	90.0
0.3000	0.7677	180.0	-0.7646	90.0
0.3500	0.7276	180.0	-0.7236	90.1
0.4000	0.6871	180.0	-0.6819	90.1
0.4500	0.6461	180.0	-0.6397	90.1
0.5000	0.6047	180.0	-0.5970	90.2
0.5500	0.5629	180.0	-0.5537	90.2
0.6000	0.5206	180.0	-0.5098	90.3
0.6500	0.4779	180.0	-0.4654	90.3
0.7000	0.4348	180.0	-0.4203	90.4
0.7500	0.3912	180.0	-0.3746	90.5
0.8000	0.3472	180.0	-0.3283	90.6
0.8500	0.3026	180.0	-0.2813	90.8
0.9000	0.2576	180.0	-0.2336	91.0
0.9500	0.2121	180.0	-0.1853	91.3
1.0000	0.1661	180.0	-0.1361	91.9
1.0500	0.1196	180.0	-0.0861	93.0
1.1000	0.0725	180.0	-0.0349	96.2
1.1435	0.0219	134.3		

a/R=3.8

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8848	90.0
0.2000	0.8468	180.0	-0.8453	90.0
0.2500	0.8075	180.0	-0.8053	90.0
0.3000	0.7677	180.0	-0.7648	90.0
0.3500	0.7275	180.0	-0.7238	90.1
0.4000	0.6869	180.0	-0.6823	90.1
0.4500	0.6459	180.0	-0.6402	90.1
0.5000	0.6044	180.0	-0.5975	90.1
0.5500	0.5625	180.0	-0.5543	90.2
0.6000	0.5202	180.0	-0.5105	90.2
0.6500	0.4774	180.0	-0.4662	90.3
0.7000	0.4341	180.0	-0.4212	90.3
0.7500	0.3904	180.0	-0.3757	90.4
0.8000	0.3461	180.0	-0.3295	90.5
0.8500	0.3014	180.0	-0.2827	90.6
0.9000	0.2562	180.0	-0.2352	90.8
0.9500	0.2105	180.0	-0.1870	91.1
1.0000	0.1643	180.0	-0.1381	91.5
1.0500	0.1175	180.0	-0.0885	92.3
1.1000	0.0702	180.0	-0.0377	94.8
1.1460	0.0193	134.4		

a/R=3.6

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8847	90.0
0.2000	0.8468	180.0	-0.8452	90.0
0.2500	0.8075	180.0	-0.8052	90.0
0.3000	0.7677	180.0	-0.7647	90.0
0.3500	0.7276	180.0	-0.7236	90.1
0.4000	0.6870	180.0	-0.6820	90.1
0.4500	0.6460	180.0	-0.6399	90.1
0.5000	0.6046	180.0	-0.5972	90.2
0.5500	0.5628	180.0	-0.5539	90.2
0.6000	0.5205	180.0	-0.5101	90.3
0.6500	0.4777	180.0	-0.4656	90.3
0.7000	0.4346	180.0	-0.4206	90.4
0.7500	0.3909	180.0	-0.3750	90.5
0.8000	0.3468	180.0	-0.3287	90.6
0.8500	0.3022	180.0	-0.2818	90.7
0.9000	0.2571	180.0	-0.2342	90.9
0.9500	0.2116	180.0	-0.1859	91.2
1.0000	0.1655	180.0	-0.1368	91.7
1.0500	0.1189	180.0	-0.0870	92.7
1.1000	0.0717	180.0	-0.0359	95.7
1.1445	0.0220	134.3		

a/R=3.9

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8848	90.0
0.2000	0.8468	180.0	-0.8453	90.0
0.2500	0.8075	180.0	-0.8054	90.0
0.3000	0.7677	180.0	-0.7649	90.0
0.3500	0.7275	180.0	-0.7239	90.1
0.4000	0.6869	180.0	-0.6824	90.1
0.4500	0.6458	180.0	-0.6403	90.1
0.5000	0.6043	180.0	-0.5977	90.1
0.5500	0.5624	180.0	-0.5545	90.2
0.6000	0.5200	180.0	-0.5107	90.2
0.6500	0.4772	180.0	-0.4664	90.2
0.7000	0.4339	180.0	-0.4215	90.3
0.7500	0.3901	180.0	-0.3760	90.4
0.8000	0.3458	180.0	-0.3299	90.5
0.8500	0.3011	180.0	-0.2831	90.6
0.9000	0.2558	180.0	-0.2357	90.7
0.9500	0.2101	180.0	-0.1876	91.0
1.0000	0.1638	180.0	-0.1387	91.4
1.0500	0.1169	180.0	-0.0891	92.2
1.1000	0.0695	180.0	-0.0385	94.5
1.1467	0.0194	134.4		

TABLE 1: (Cont)

a/R=4.0

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8848	90.0
0.2000	0.8468	180.0	-0.8454	90.0
0.2500	0.8074	180.0	-0.8054	90.0
0.3000	0.7677	180.0	-0.7650	90.0
0.3500	0.7275	180.0	-0.7240	90.1
0.4000	0.6868	180.0	-0.6825	90.1
0.4500	0.6457	180.0	-0.6404	90.1
0.5000	0.6042	180.0	-0.5978	90.1
0.5500	0.5623	180.0	-0.5547	90.2
0.6000	0.5199	180.0	-0.5109	90.2
0.6500	0.4770	180.0	-0.4666	90.2
0.7000	0.4336	180.0	-0.4218	90.3
0.7500	0.3898	180.0	-0.3763	90.3
0.8000	0.3455	180.0	-0.3302	90.4
0.8500	0.3007	180.0	-0.2835	90.5
0.9000	0.2554	180.0	-0.2361	90.7
0.9500	0.2096	180.0	-0.1881	90.9
1.0000	0.1633	180.0	-0.1393	91.3
1.0500	0.1163	180.0	-0.0898	92.0
1.1000	0.0689	180.0	-0.0393	94.2
1.1473	0.0194	134.4		

a/R=4.6

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9238	90.0
0.1500	0.8857	180.0	-0.8849	90.0
0.2000	0.8467	180.0	-0.8455	90.0
0.2500	0.8073	180.0	-0.8057	90.0
0.3000	0.7675	180.0	-0.7653	90.0
0.3500	0.7272	180.0	-0.7244	90.0
0.4000	0.6865	180.0	-0.6830	90.1
0.4500	0.6453	180.0	-0.6410	90.1
0.5000	0.6037	180.0	-0.5985	90.1
0.5500	0.5616	180.0	-0.5555	90.1
0.6000	0.5191	180.0	-0.5119	90.1
0.6500	0.4760	180.0	-0.4678	90.2
0.7000	0.4325	180.0	-0.4231	90.2
0.7500	0.3885	180.0	-0.3778	90.2
0.8000	0.3440	180.0	-0.3319	90.3
0.8500	0.2990	180.0	-0.2854	90.4
0.9000	0.2534	180.0	-0.2383	90.5
0.9500	0.2073	180.0	-0.1905	90.6
1.0000	0.1607	180.0	-0.1420	90.9
1.0500	0.1135	180.0	-0.0928	91.4
1.1000	0.0657	180.0	-0.0427	92.8
1.1499	0.0136	134.6		

a/R=4.2

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9237	90.0
0.1500	0.8857	180.0	-0.8848	90.0
0.2000	0.8468	180.0	-0.8454	90.0
0.2500	0.8074	180.0	-0.8055	90.0
0.3000	0.7676	180.0	-0.7651	90.0
0.3500	0.7274	180.0	-0.7241	90.0
0.4000	0.6867	180.0	-0.6826	90.1
0.4500	0.6456	180.0	-0.6406	90.1
0.5000	0.6040	180.0	-0.5981	90.1
0.5500	0.5620	180.0	-0.5550	90.1
0.6000	0.5196	180.0	-0.5113	90.2
0.6500	0.4766	180.0	-0.4671	90.2
0.7000	0.4332	180.0	-0.4223	90.2
0.7500	0.3893	180.0	-0.3769	90.3
0.8000	0.3450	180.0	-0.3308	90.4
0.8500	0.3001	180.0	-0.2842	90.5
0.9000	0.2547	180.0	-0.2369	90.6
0.9500	0.2088	180.0	-0.1890	90.8
1.0000	0.1623	180.0	-0.1403	91.1
1.0500	0.1153	180.0	-0.0909	91.8
1.1000	0.0677	180.0	-0.0406	93.6
1.1483	0.0165	134.5		

a/R=4.8

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9238	90.0
0.1500	0.8857	180.0	-0.8849	90.0
0.2000	0.8467	180.0	-0.8456	90.0
0.2500	0.8073	180.0	-0.8057	90.0
0.3000	0.7675	180.0	-0.7654	90.0
0.3500	0.7272	180.0	-0.7245	90.0
0.4000	0.6864	180.0	-0.6831	90.0
0.4500	0.6452	180.0	-0.6412	90.1
0.5000	0.6036	180.0	-0.5987	90.1
0.5500	0.5614	180.0	-0.5557	90.1
0.6000	0.5188	180.0	-0.5122	90.1
0.6500	0.4758	180.0	-0.4681	90.1
0.7000	0.4322	180.0	-0.4234	90.2
0.7500	0.3881	180.0	-0.3782	90.2
0.8000	0.3436	180.0	-0.3324	90.3
0.8500	0.2985	180.0	-0.2859	90.3
0.9000	0.2529	180.0	-0.2388	90.4
0.9500	0.2067	180.0	-0.1911	90.6
1.0000	0.1600	180.0	-0.1427	90.8
1.0500	0.1127	180.0	-0.0936	91.2
1.1000	0.0648	180.0	-0.0436	92.4
1.1500	0.0154	147.0	0.0106	124.0
1.1505	0.0135	134.6		

a/R=4.4

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9621	90.0
0.1000	0.9242	180.0	-0.9238	90.0
0.1500	0.8857	180.0	-0.8849	90.0
0.2000	0.8468	180.0	-0.8455	90.0
0.2500	0.8074	180.0	-0.8056	90.0
0.3000	0.7676	180.0	-0.7652	90.0
0.3500	0.7273	180.0	-0.7243	90.0
0.4000	0.6866	180.0	-0.6828	90.1
0.4500	0.6455	180.0	-0.6408	90.1
0.5000	0.6039	180.0	-0.5983	90.1
0.5500	0.5618	180.0	-0.5552	90.1
0.6000	0.5193	180.0	-0.5116	90.1
0.6500	0.4763	180.0	-0.4675	90.2
0.7000	0.4329	180.0	-0.4227	90.2
0.7500	0.3889	180.0	-0.3774	90.3
0.8000	0.3445	180.0	-0.3314	90.3
0.8500	0.2995	180.0	-0.2848	90.4
0.9000	0.2540	180.0	-0.2376	90.5
0.9500	0.2080	180.0	-0.1898	90.7
1.0000	0.1615	180.0	-0.1412	91.0
1.0500	0.1143	180.0	-0.0919	91.5
1.1000	0.0666	180.0	-0.0417	93.2
1.1492	0.0166	134.5		

a/R=5.0

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9622	90.0
0.1000	0.9242	180.0	-0.9238	90.0
0.1500	0.8857	180.0	-0.8850	90.0
0.2000	0.8467	180.0	-0.8456	90.0
0.2500	0.8073	180.0	-0.8058	90.0
0.3000	0.7674	180.0	-0.7654	90.0
0.3500	0.7271	180.0	-0.7246	90.0
0.4000	0.6863	180.0	-0.6832	90.0
0.4500	0.6451	180.0	-0.6413	90.1
0.5000	0.6034	180.0	-0.5989	90.1
0.5500	0.5613	180.0	-0.5559	90.1
0.6000	0.5186	180.0	-0.5124	90.1
0.6500	0.4755	180.0	-0.4684	90.1
0.7000	0.4319	180.0	-0.4238	90.2
0.7500	0.3878	180.0	-0.3786	90.2
0.8000	0.3432	180.0	-0.3328	90.2
0.8500	0.2981	180.0	-0.2864	90.3
0.9000	0.2524	180.0	-0.2393	90.4
0.9500	0.2062	180.0	-0.1917	90.5
1.0000	0.1594	180.0	-0.1433	90.7
1.0500	0.1120	180.0	-0.0943	91.1
1.1000	0.0641	180.0	-0.0444	92.2
1.1500	0.0152	155.1	0.0086	119.1
1.1510	0.0135	134.6		

TABLE 1: (Concluded)

a/R=5.2

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9622	90.0
0.1000	0.9242	180.0	-0.9238	90.0
0.1500	0.8857	180.0	-0.8850	90.0
0.2000	0.8467	180.0	-0.8457	90.0
0.2500	0.8072	180.0	-0.8058	90.0
0.3000	0.7674	180.0	-0.7655	90.0
0.3500	0.7270	180.0	-0.7247	90.0
0.4000	0.6862	180.0	-0.6833	90.0
0.4500	0.6450	180.0	-0.6414	90.0
0.5000	0.6033	180.0	-0.5991	90.1
0.5500	0.5611	180.0	-0.5561	90.1
0.6000	0.5184	180.0	-0.5127	90.1
0.6500	0.4753	180.0	-0.4686	90.1
0.7000	0.4317	180.0	-0.4240	90.1
0.7500	0.3875	180.0	-0.3789	90.2
0.8000	0.3429	180.0	-0.3331	90.2
0.8500	0.2977	180.0	-0.2868	90.3
0.9000	0.2520	180.0	-0.2398	90.3
0.9500	0.2057	180.0	-0.1922	90.4
1.0000	0.1588	180.0	-0.1439	90.6
1.0500	0.1114	180.0	-0.0949	91.0
1.1000	0.0634	180.0	-0.0451	91.9
1.1500	0.0147	163.8	0.0072	115.5
1.1514	0.0105	134.7		

a/R=5.8

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9622	90.0
0.1000	0.9242	180.0	-0.9239	90.0
0.1500	0.8856	180.0	-0.8851	90.0
0.2000	0.8466	180.0	-0.8458	90.0
0.2500	0.8072	180.0	-0.8060	90.0
0.3000	0.7672	180.0	-0.7657	90.0
0.3500	0.7269	180.0	-0.7249	90.0
0.4000	0.6860	180.0	-0.6836	90.0
0.4500	0.6447	180.0	-0.6418	90.0
0.5000	0.6029	180.0	-0.5995	90.0
0.5500	0.5607	180.0	-0.5566	90.1
0.6000	0.5180	180.0	-0.5132	90.1
0.6500	0.4747	180.0	-0.4693	90.1
0.7000	0.4310	180.0	-0.4248	90.1
0.7500	0.3868	180.0	-0.3797	90.1
0.8000	0.3420	180.0	-0.3340	90.2
0.8500	0.2967	180.0	-0.2878	90.2
0.9000	0.2509	180.0	-0.2409	90.2
0.9500	0.2045	180.0	-0.1934	90.3
1.0000	0.1575	180.0	-0.1453	90.4
1.0500	0.1099	180.0	-0.0964	90.7
1.1000	0.0617	180.0	-0.0469	91.4
1.1500	0.0128	180.0	0.0043	108.1
1.1523	0.0103	134.7		

a/R=5.4

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9622	90.0
0.1000	0.9242	180.0	-0.9238	90.0
0.1500	0.8857	180.0	-0.8850	90.0
0.2000	0.8467	180.0	-0.8457	90.0
0.2500	0.8072	180.0	-0.8059	90.0
0.3000	0.7673	180.0	-0.7656	90.0
0.3500	0.7270	180.0	-0.7248	90.0
0.4000	0.6862	180.0	-0.6834	90.0
0.4500	0.6449	180.0	-0.6416	90.0
0.5000	0.6032	180.0	-0.5992	90.1
0.5500	0.5610	180.0	-0.5563	90.1
0.6000	0.5183	180.0	-0.5129	90.1
0.6500	0.4751	180.0	-0.4689	90.1
0.7000	0.4314	180.0	-0.4243	90.1
0.7500	0.3872	180.0	-0.3792	90.2
0.8000	0.3426	180.0	-0.3335	90.2
0.8500	0.2973	180.0	-0.2871	90.2
0.9000	0.2516	180.0	-0.2402	90.3
0.9500	0.2052	180.0	-0.1926	90.4
1.0000	0.1583	180.0	-0.1444	90.6
1.0500	0.1109	180.0	-0.0955	90.9
1.1000	0.0628	180.0	-0.0458	91.7
1.1500	0.0140	180.0	0.0061	112.6
1.1518	0.0104	134.7		

a/R=6.0

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9622	90.0
0.1000	0.9242	180.0	-0.9239	90.0
0.1500	0.8856	180.0	-0.8851	90.0
0.2000	0.8466	180.0	-0.8458	90.0
0.2500	0.8071	180.0	-0.8060	90.0
0.3000	0.7672	180.0	-0.7657	90.0
0.3500	0.7268	180.0	-0.7250	90.0
0.4000	0.6860	180.0	-0.6837	90.0
0.4500	0.6446	180.0	-0.6419	90.0
0.5000	0.6029	180.0	-0.5996	90.0
0.5500	0.5606	180.0	-0.5567	90.0
0.6000	0.5178	180.0	-0.5133	90.1
0.6500	0.4746	180.0	-0.4694	90.1
0.7000	0.4308	180.0	-0.4250	90.1
0.7500	0.3866	180.0	-0.3799	90.1
0.8000	0.3418	180.0	-0.3343	90.1
0.8500	0.2964	180.0	-0.2881	90.2
0.9000	0.2506	180.0	-0.2412	90.2
0.9500	0.2041	180.0	-0.1938	90.3
1.0000	0.1571	180.0	-0.1456	90.4
1.0500	0.1095	180.0	-0.0968	90.6
1.1000	0.0612	180.0	-0.0473	91.3
1.1500	0.0123	180.0	0.0036	106.4
1.1526	0.0073	134.8		

a/R=5.6

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9622	90.0
0.1000	0.9242	180.0	-0.9239	90.0
0.1500	0.8856	180.0	-0.8850	90.0
0.2000	0.8466	180.0	-0.8457	90.0
0.2500	0.8072	180.0	-0.8059	90.0
0.3000	0.7673	180.0	-0.7656	90.0
0.3500	0.7269	180.0	-0.7248	90.0
0.4000	0.6861	180.0	-0.6835	90.0
0.4500	0.6448	180.0	-0.6417	90.0
0.5000	0.6031	180.0	-0.5993	90.0
0.5500	0.5608	180.0	-0.5564	90.1
0.6000	0.5181	180.0	-0.5130	90.1
0.6500	0.4749	180.0	-0.4691	90.1
0.7000	0.4312	180.0	-0.4245	90.1
0.7500	0.3870	180.0	-0.3794	90.1
0.8000	0.3423	180.0	-0.3338	90.2
0.8500	0.2970	180.0	-0.2875	90.2
0.9000	0.2512	180.0	-0.2406	90.3
0.9500	0.2048	180.0	-0.1930	90.4
1.0000	0.1579	180.0	-0.1449	90.5
1.0500	0.1104	180.0	-0.0960	90.8
1.1000	0.0622	180.0	-0.0463	91.6
1.1500	0.0134	180.0	0.0051	110.2
1.1521	0.0104	134.7		

a/R=INFINITY

λ/(Y/E)	S/Y	THETA	S/Y	THETA
0.0000	1.0000		-1.0000	
0.0500	0.9623	180.0	-0.9623	90.0
0.1000	0.9241	180.0	-0.9241	90.0
0.1500	0.8854	180.0	-0.8854	90.0
0.2000	0.8462	180.0	-0.8462	90.0
0.2500	0.8066	180.0	-0.8066	90.0
0.3000	0.7665	180.0	-0.7665	90.0
0.3500	0.7259	180.0	-0.7259	90.0
0.4000	0.6849	180.0	-0.6849	90.0
0.4500	0.6433	180.0	-0.6433	90.0
0.5000	0.6013	180.0	-0.6013	90.0
0.5500	0.5587	180.0	-0.5587	90.0
0.6000	0.5157	180.0	-0.5157	90.0
0.6500	0.4721	180.0	-0.4721	90.0
0.7000	0.4280	180.0	-0.4280	90.0
0.7500	0.3833	180.0	-0.3833	90.0
0.8000	0.3381	180.0	-0.3381	90.0
0.8500	0.2923	180.0	-0.2923	90.0
0.9000	0.2459	180.0	-0.2459	90.0
0.9500	0.1990	180.0	-0.1990	90.0
1.0000	0.1514	180.0	-0.1514	90.0
1.0500	0.1032	180.0	-0.1032	90.0
1.1000	0.0543	180.0	-0.0543	90.0
1.1500	0.0047	180.0	-0.0047	90.0
1.1547	0.0000			

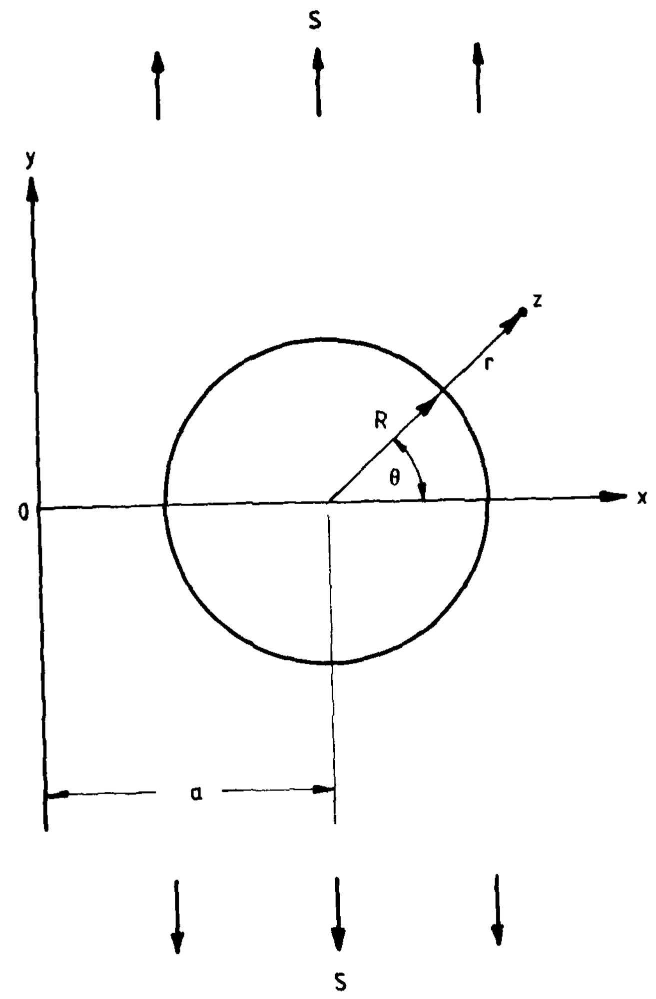

FIG. 1: HALF-PLANE CONTAINING AN INTERFERENCE-FIT DISC UNDER REMOTE LOADING

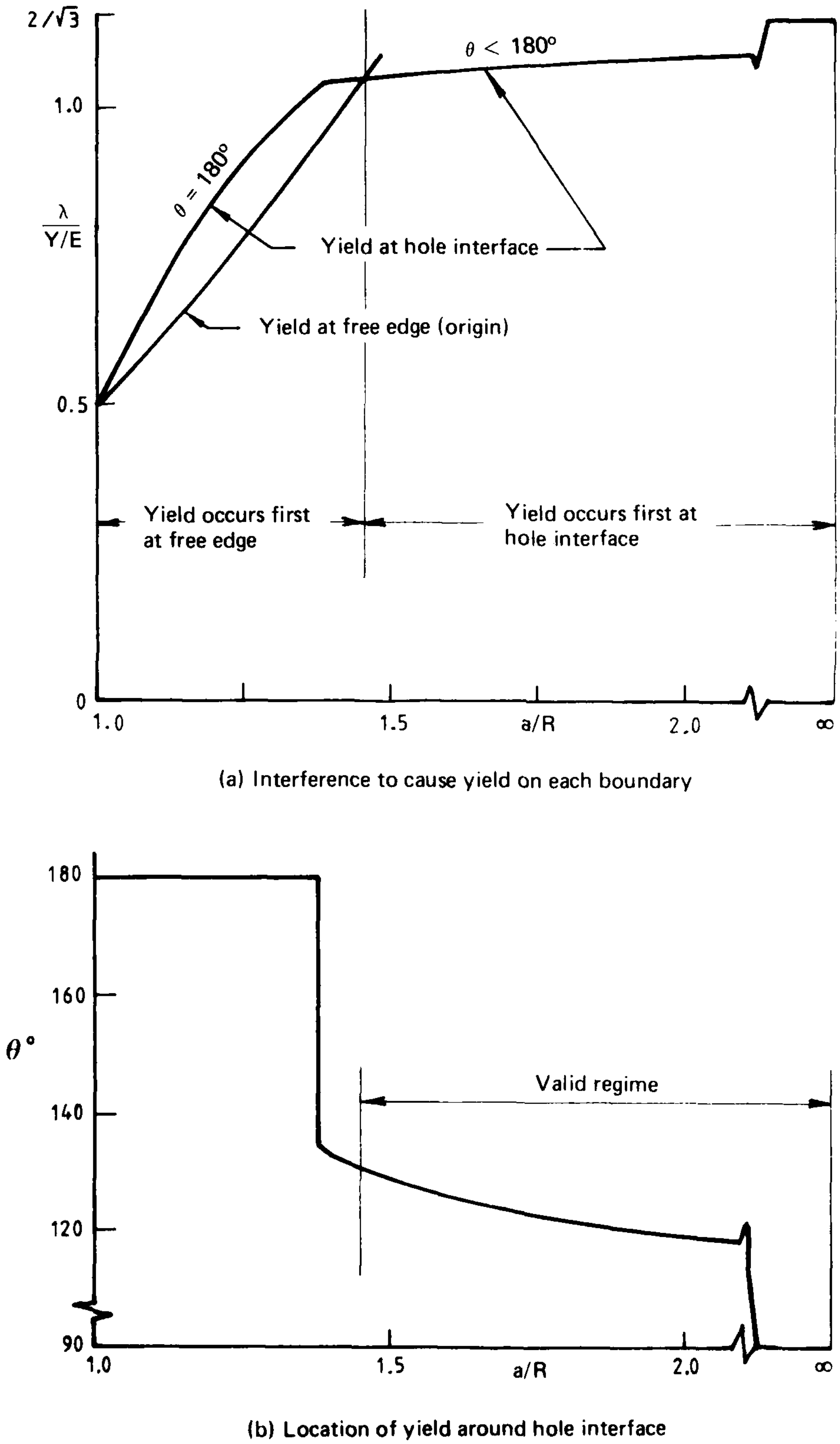

FIG. 2: INITIATION OF YIELD FROM INTERFERENCE-FIT STRESSES ALONE (S/Y = 0)

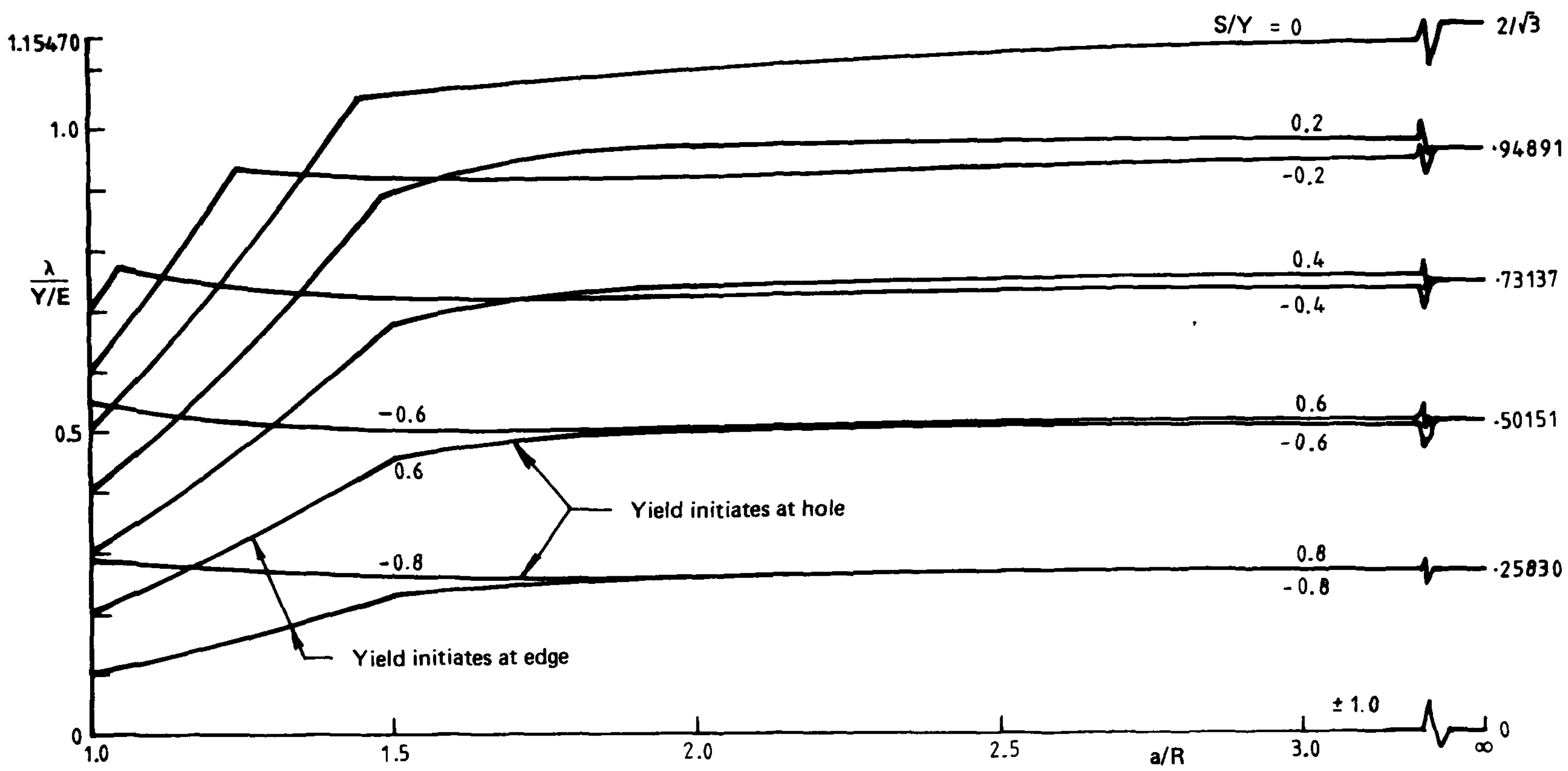

FIG. 3: LOADING PARAMETER COMBINATIONS TO INITIATE YIELD

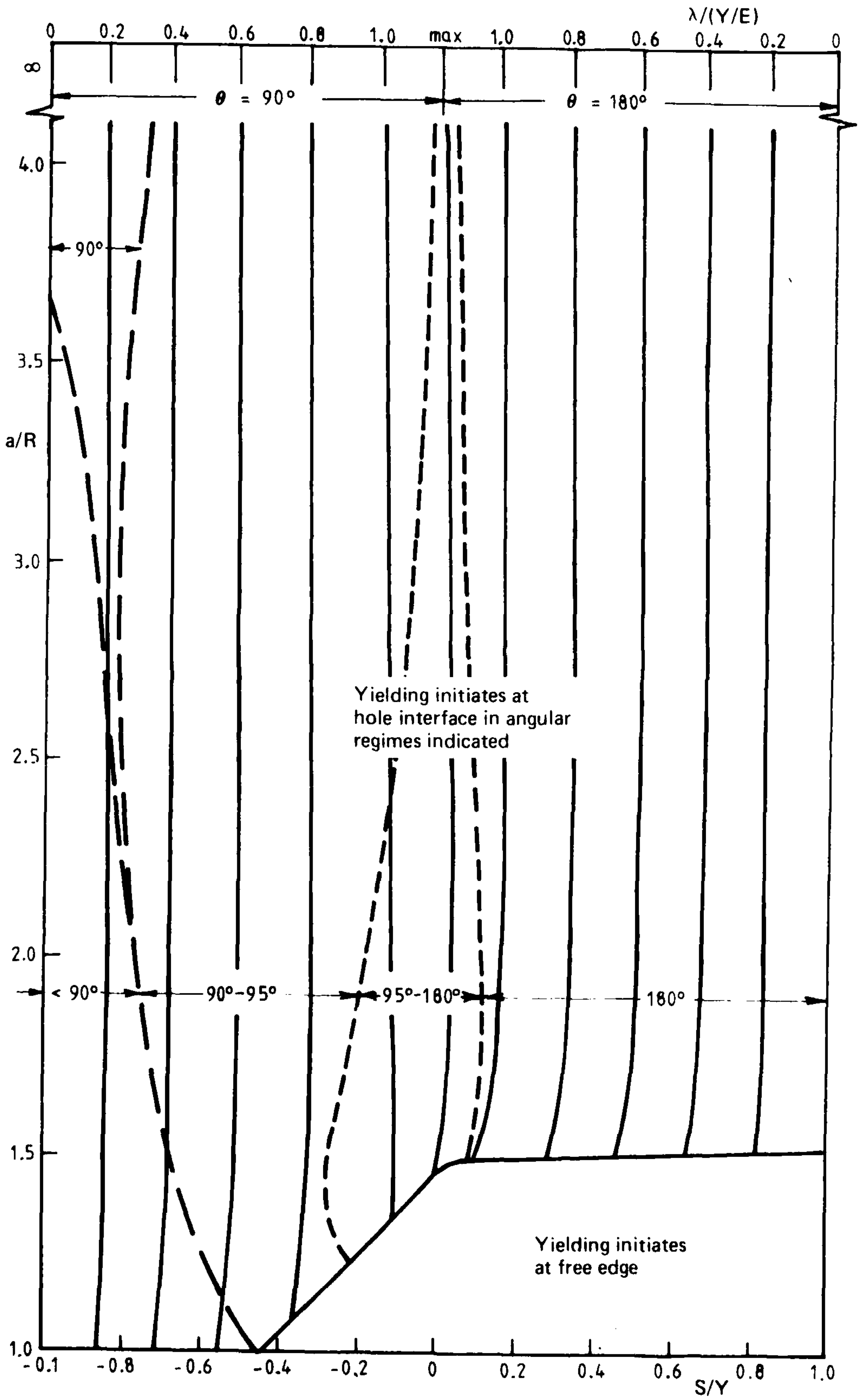

FIG. 4: LOCATION OF INITIATION OF YIELD

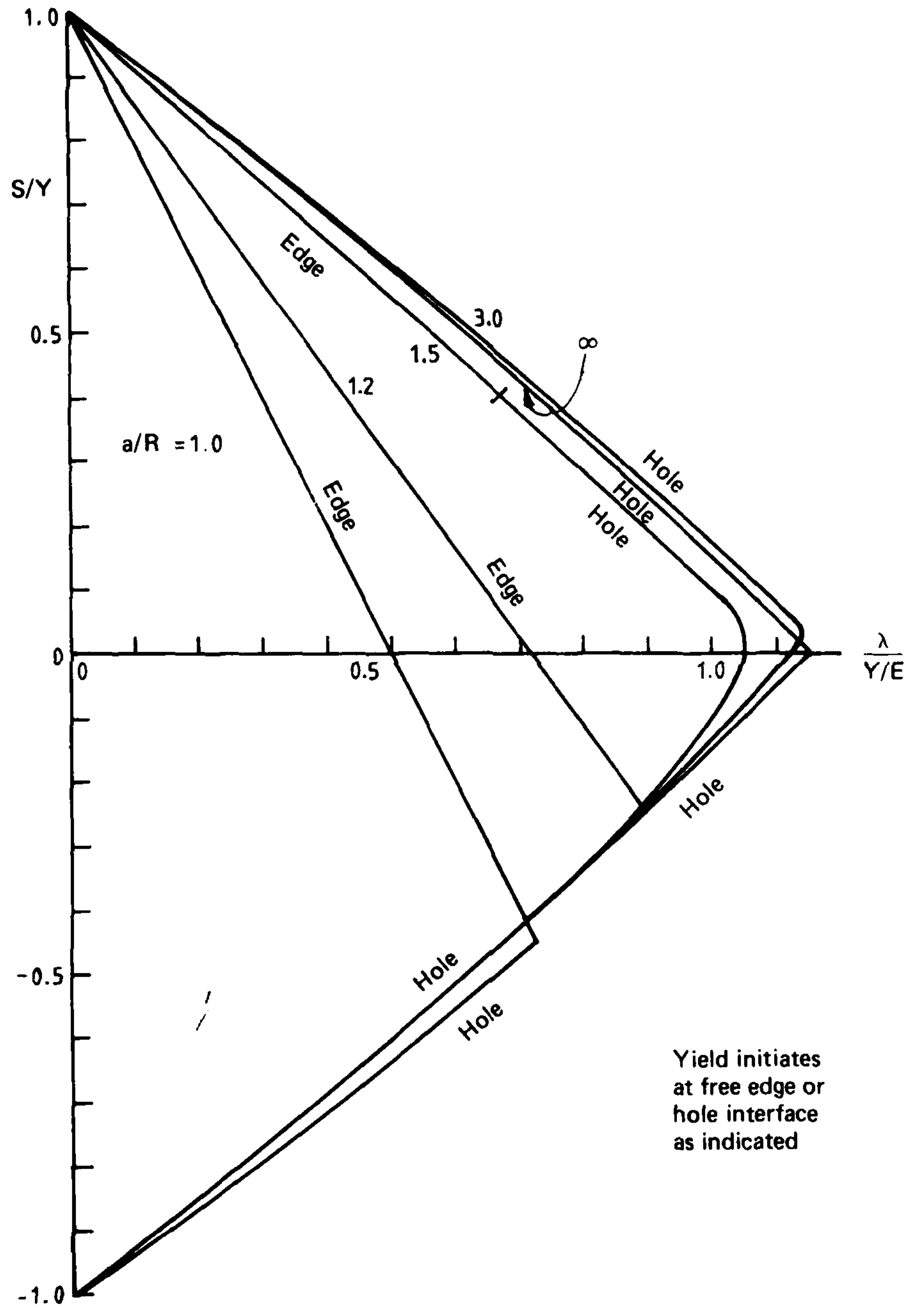

FIG. 5(a): LOADING PARAMETER COMBINATIONS TO INITIATE YIELD FOR GIVEN EDGE DISTANCE RATIO

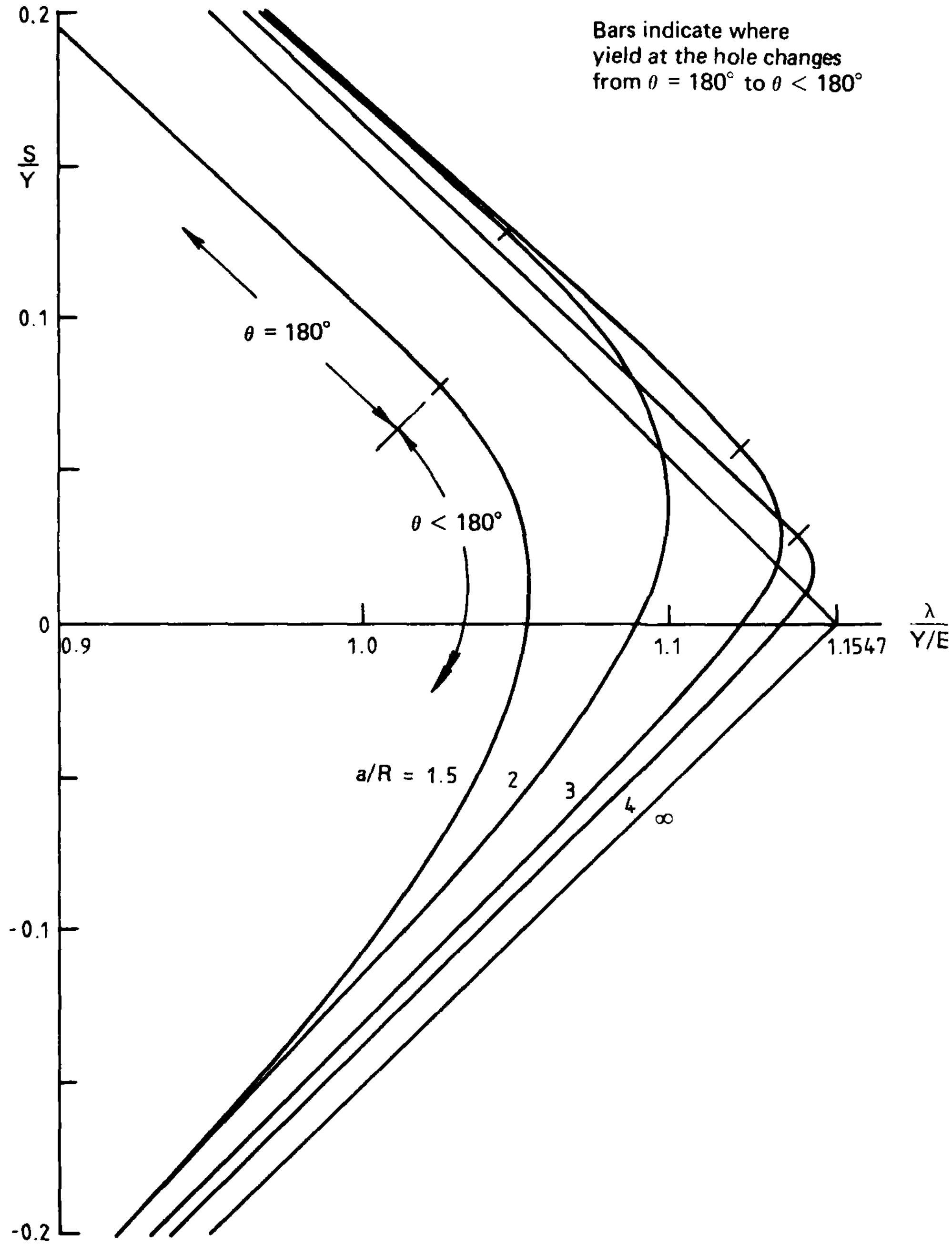

FIG. 5(b): LOADING PARAMETER COMBINATIONS TO INITIATE YIELD AT HOLE INTERFACE FOR GIVEN EDGE DISTANCE RATIO – DETAIL OF RHS OF FIG. 5(a).

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16. Abstract

The threshold combinations of interference-fit and remote loading required to initiate yield in a half-plane containing a bonded disc of the same material are evaluated analytically. Comprehensive tabular data are given over the full range of ratio of hole edge distance to hole radius, together with graphical presentations for selected cases.

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